TREATMENT OF FRESH AND UN-UNITED INTRACAPSULAR FRACTURE NECK FEMUR BY INTERNAL FIXATION AND MUSCLE PEDICLE BONE GRAFTING

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C E R T I F I C A T E

This is to certify that the work entitled "TREATMENT OF FRESH AND UNUNITED INTRACAPSULAR FRACTURE NECK FEMUR BY INTERNAL FIXATION AND MUSCLE PEDICLE BONE GRAFTING", has been carried out by DR. AJAY KUMAR himself in this department.

He has put in the necessary stay in the department as required by the regulation of Bundelkhand University.

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C E R T I F I C A T E

This is to certify that the work entitled "TREATMENT OF FRESH AND UNUNITED INTRACAPSULAR FRACTURE NECK FEMUR BY INTERNAL FIXATION AND MUSCLE PEDICLE BONE GRAFTING", which is being submitted as a thesis for M.S. (Orthopaedic Surgery), was carried out by DR. AJAY KUMAR, under my constant supervision and guidance.

The techniques embodied in this work were undertaken by the candidate himself. The results and observations were checked and verified by me periodically.

Dated : 31.8.88

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I take the privilege to thank whole-heartedly to Dr. Anurag, M.S., Lecturer, Department of Orthopaedics for his immense co-operation, kind advice and trusted help at every juncture.

Friends in need are friends indeed. I am proud of them and I would fail in my duty if I do not thank my colleagues and friends. I am highly thankful to Dr. Rakesh Chawla, my senior colleague but more like a friend who has kept my academic interest alive. Dr. K.K. Pandey and Dr. Pankaj Gupta were ever ready to chip in with help and moral support.

Radiographs were an integral part of this project. I express my genuine thanks to Prof. H.N. Saxena, Dr. A.K.Gupta, Dr. H.K. Uxa (Uxa X-ray Centre) and staff of the Radiology Department, M.L.B. Medical College, Jhansi, for immense co-operation and allowing me to avail every possible facility.

I feel proud of my respected parents who have been an incessant source of blessings and encouragement which keeps me going. It is by their grace that I am able to fulfil this dream and shall be able to rise further in my life.

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INTRODUCTION

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Fracture neck femur poses a great challenge to orthopaedic surgeons and remains an unsolved problem as far as its management is concerned in many ways. The surgeons have some control over the problem of non-union of the femoral neck fracture, but none over avascular necrosis of femoral head. The femoral neck fracture is entirely intracapsular and as in other intracapsular fractures, the synovial fluid bathing the fracture interferes with the orderly healing process. Furthermore, the femoral neck has essentially no periosteal cambium layer; therefore all healing must be endosteal. These two factors along with precarious blood supply to femoral head make healing unpredictable and non-union fairly frequent.

Vonlangenbeck was the first to use internal fixation for femoral neck fracture in 1850-1878. After Vonlangenbeck, Koning (1875), Nicolasysen (1897) and Hey Groves (1916) used various devices for internal fixation with the aim of, secured and rigid fixation, out of which Smith Peterson triflanged nail gained maximum popularity but at present it is gradually getting out of use because superior fixation devices available. Multiple pinning, Deyerle apparatus, Gardan screws, Asnis screws

or a sliding screw apparatus like Richards or Zimmer compression screw, the Calandruccio compression devices or a combination of devices such as compression screw and side plate assembly with one or two supplemental threaded pins.

Multiple pinning is one of the latest treatment which prevent rotation and provide good fixation and check other shearing movements at fracture site.

Frangakis in 1966 observed that almost all the cases of femoral neck fracture, had comminution of posterior cervical cortex and due to this comminution, traction and internal rotation brings into contact only the anterior portion of the fracture surfaces of the femoral neck. Thus it appeared that bone grafting along with internal fixation could be more advantageous.

Non-union, avascular necrosis and late segmental collapse are the two principle complications of femoral neck fracture inspite of anatomical reduction, impaction and rigid internal fixation.

So surgeons think over the third essential factor, the precarious blood supply of femoral head. So attempt to restore blood supply were attempted from time to time.

To overcome the problem of poor vascularity, many workers (Helstadius, 1942; Stuck & Hinchey, 1944; Baadsgaard and Medgyesi, 1965) studied the role of muscle pedicle bone graft in experimental animals.

In 1962, Judet was first to use the quadratus femoris as a muscle pedicle bone graft in cases of displaced femoral neck fractures to improve vascularity of head fragment.

Meyer's, Harvey and Moore (1973, 74) studied the role of muscle pedicle bone grafting with internal fixation in fracture neck femur and reported good results in 95% of cases. However, late segmental collapse occurred in 5% of united femoral neck fractures.

Baksi in 1983 studied the role of muscle pedicle bone grafting in avascular necrosis of femoral head and utilized this principle, of improving vascularity with muscle pedicle bone grafting, in treatment of femoral neck fractures and reported satisfactory union in 75% of cases, delayed union in 12%, non-union in 9% and technique failure in 4%.

We undertook the present study to establish the role of muscle pedicle bone grafting with internal fixation in treatment of fresh as well as un-united cases of femoral neck fractures.

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REVIEW OF LITERATURE

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Fractures of femoral neck, though known from time immemorial have always been posing challenge to orthopaedic surgeons because of the problems of non-union and avascular necrosis irrespective of the method of treatment. Volumes and volumes are available but still there is no unanimity over the most successful method of treatment. Anatomical reduction, impaction and rigid internal fixation are considered to be the pre-requisites for union of the femoral neck fractures.

Even if the fracture unites, the vascularity of the femoral head can not be predicted upon and avascular necrosis of the femoral head takes place in about 10 to 15% of cases.

To overcome the problem of avascular necrosis, Helstadius (1942) came with the idea of muscle pedicle bone grafting. Impressed with this idea, workers (Judet, 1962; Meyers and Harvey, 1974) used this principle of muscle pedicle bone grafting with internal fixation in treatment of femoral neck fractures.

Anatomy of fracture neck femur -

Proximal femur consists of femoral head, neck, greater trochanter and lesser trochanter and is covered by

periosteum beneath synovium but periosteum does not have cambium layer, which is essential for callus formation after fracture as shown by Banks (1964).

At the base of femoral neck and at the level of capsular attachment, there is an extra-capsular arterial ring of arteries from which ascending cervical branches arise along the neck, around its circumference, as shown by Trueta and Harison (1953). These arteries at the Junction between articular cartilage of head and bony surface of neck, forms subsynovial anastomatic ring, known as circulus articuli vasculosus of Hunter; also give rise to metaphyseal and epiphyseal branches and within epiphysis, there is no anastomosis between sinusoidal termination of epiphyseal arteries before secondary centre of ossification appear.

Chung (1956) stated that vascular patterns which are established at the time of birth does not change throughout life. Vessels within the bone do not cross between epiphysis and metaphysis until the closure of epiphyseal plate.

Trueta (1957) described vascular pattern of femoral head as follows -

<u>At birth</u> -

Vessels of ligamentum teres are insignificant and supply only the limited area of head about the fovea

with vessels radiating outward like a laural leaf. Major supply of femoral head is by ascending cervical arteries (metaphyseal and lateral epiphyseal arteries of trueta).

Infantile (4 months to 4 years) -

At 4 months main blood supply of femoral head is from ascending cervical arteries but after 4 months vertical metaphyseal vessels decreases in size and number and provide little blood supply but the lateral epiphyseal vessels play major role for vascularity of head.

Intermediate (3-7 years) -

As the epiphyseal plate is a firm barrier between the epiphysis and metaphysis, the lateral epiphyseal vessels are the main source of blood supply.

Pre-adolescent (9 - 10 years) -

After 7 years ligamentum teres vessels become more prominent and extend deeper into epiphysis and anastomose with lateral epiphyseal vessels known as medial metaphyseal vessels.

Adolescent period -

Lateral epiphyseal vessels are the main source of blood supply with increasing prominence of ligamentum teres vessels.

As the period of skeletal maturity and epiphyseal fusion approaches, the metaphyseal arteries anastomose with terminal branches of medullary nutrient artery but they can not be traced upward into the femoral neck as discrete trunks.

Crock (1965) described that after epiphyseal fusion, epiphyseal and metaphyseal vessels effectively anastomose with each other at the surface of femoral neck.

Epiphyseal plate of bone is a firm barrier for anastomosis between vessels supplying the epiphysis and metaphysis until skeletal maturity, when two vascular systems blend. Main arterial supply of the proximal femur is derived from the branches of extra-capsular arterial ring and subsynovial intra-articular ring of the femoral neck.

Chung (1956) said that arteries running in the ligamentum teres of the head of the femur supplement the blood supply of the head.

Classification of the fracture neck femur -

Pauwel (1935) classified the femoral neck fracture on the basis of angle of inclination of fracture line across the neck. With type I being more horizontal and type III more vertical.

Pauwel type I - includes the femoral neck fractures where the fracture line is almost horizontal (angle of inclination less than 30°), any shearing force causes impaction and chances of union are best.

Type II - Fracture line is oblique, angle of inclination being between 30 - 70°, needs internal fixation to prevent distraction at fracture site.

Type III - Fracture line is almost vertical and angle of inclination is 70° or more and have got worst prognosis.

Boyd & George (1948) and Boyd & Salvatore (1964) evaluated that rate of avascular necrosis and non-union could not be correlated with increasing angle of the fracture. They observed that Pauwels' type I fractures (impacted type) treated by internal fixation, none developed non-union and none become displaced but 13% ultimately developed avascular necrosis. Type II fractures, treated by internal fixation, developed non-union in 12% and avascular necrosis in 33% and of type III fractures treated by internal fixation, non-union occur only in 8% with avascular necrosis in 30 %.

It thus appear that broader fracture surfaces of Pauwels' type III, fracture tend to unite radially, provided that shearing forces are sufficiently negotiated

Garden (1961), Klenerman and Marcuson (1970) were also of the view that it is very difficult to know the exact angle of fracture across the femoral neck from the routine antero-posterior roentgenogram. They suggested that Pauwels' classification based on the roentgenographic shadow of fracture line, can be altered very well by rotation of distal fragment, that is in one position of rotation, fracture may appear Pauwels' type I and in other position Pauwels' type III.

Garden (1961) classified the femoral neck fractures by radiographic appearance on the basis of the degree of displacement. This classification is helpful in treatment decision and he classified them into four groups :

Type I - Incomplete fracture with head tilted in postero-lateral direction.

Type II - Undisplaced complete fracture.

Type III - Complete fracture with partial displacement.

Type IV - Complete fracture with full displacement and both proximal and distal fragment have no contact.

According to this classification type III & IV fractures have maximum chances of complications.

Singh, Nagarth and Mani (1970) considered the quality of bone of the patients. Many patients with femoral neck fracture have markedly porotic bone. The quality of fixation and stresses which can be tolerated post-operatively are related to the severity of porosis.

Singh's index which denotes the quality of bone, is based on trabecular pattern of proximal femur.

Group 6 - Normal trabecular pattern with primary compression and tension trabeculae and secondary compression trabeculae.

Grade 5 - Decrease in secondary trabecular pattern and Wart's triangle become prominent.

Grade 4 - Secondary trabecular pattern is absent and primary trabecular pattern decreased.

Grade 3 - A break occurs in tension trabeculae.

Grade 2 - Loss of primary trabeculae is complete and there is a marked reduction in compression trabeculae.

Grade 1 - Only a few compression trabeculae seen.

This grading shows that fixation is proportional to grade, higher the grade better the fixation. Grade 3 and below indicate significant osteoporosis.

These grades should be determined when considering internal fixation and whether or not weight bearing will be tolerated in post-operative period.

Vascular supply in femoral neck fracture -

Chandler (1940) described limited anastomosis between the intra-osseous vessels in the femoral head and lateral and medial epiphyseal vessels and limited anastomosis of the branches of the lateral epiphyseal artery with one and the other. He stated that venous occlusion is second important factor and parallel to the degree of arterial damages. He also compared the pattern of intra-osseous arteries in femoral head with avascular area seen in bisected specimen with partial avascular necrosis which indicate that the configuration of the avascular areas coincides with how much of the arterial supply is interrupted and occluded. He also reported that venous interruption and occlusion are also important factors for avascular necrosis.

Smith (1959) showed that the vessels of ligamentum teres of femoral head obstructed in two rotational malposition of the head (i) clockwise rotation round the antero-posterior axis (valgus deformity) and (ii) rotation in either direction round the longitudinal axis of the neck. These vessels becoming more and more responsible for vascular supply of the femoral head with advancing age.

Soto-Hall & co-workers (1963) suggested that with an intact capsule, the haemarthrosis due to fracture may produce a tamponade effect, that will occlude retinacular vessels. In addition, internal rotation of hip increases the intracapsular pressure of the hip joint. Maintenance of internal rotation of hip for one or two hours may increase the vascular damage by increasing the pressure probably.

Deyerle in 1965 stated that in the more avascular cases blood vessel buds must grow into the head of femur from fracture and periosteum. The vulnerable point in fracture during first 6 months is not the head but the fracture line. The growing vessels must be protected until union occurs. Any motion at fracture site, particularly piston-like shearing and rotational motion, damages these blood vessels and causes hyperemic decalcification of the fracture line. This hyperemic decalcification causes shortening of the neck and additional loss of fixation with disruption of the fracture. The damaged blood vessels lay down an area of fibrotic scar tissue that prevents additional blood vessels to grow across the fracture line. This may lead to collapse of reduction, non-union or avascular necrosis.

Frangakis (1966) stated that damage to extra-osseous vessels, mainly lateral epiphyseal vessels is directly related to displacement of the fracture and

comminution in postero-superior cortex which ultimately leads to increased incidence of avascular necrosis. He also described that femoral head suspended from the acetabulum by the ligamentum teres which is subjected to rotational malposition in three planes - the vertical plane, the antero-posterior and the long axis of the neck of the femur. Residual displacement of the femoral head in one of these planes may obstruct remaining blood supply as initial displacement damages the epiphyseal vessels and it is one of the main cause of avascular necrosis of femoral head.

On the contrary, Netter (1953) & Crock (1967) showed that interruption of extra-osseous vessels alone did not significantly jeoparadize the blood supply of head, because femoral head is also supplied by branches of metaphyseal and retinacular intra-medullary vessels, interrupted at the level of fracture.

William & Stephen et al (1974) in their study and previously reported series, considered avascular necrosis only when it occurred in association with united fracture. They stated that when an intra-capsular fracture occurs, the blood supply of the femoral head may be damaged either by the displacement or by some other factor. Once this occurs, the healing process is associated with revascularization of the necrotic head. They believe that

no method of reduction and internal fixation will reduce the incidence of avascular necrosis below 11% found in 101 cases of undisplaced femoral neck fractures and in 15% of 135 united displaced intra-capsular femoral neck fractures in their series in the follow-up of 6 months to 1 year duration. The incidence may increase with further follow-up. They also supported the view of Mecaroll (1953) that incidence of avascular necrosis does not decrease with early surgery even within one or two days after the fracture.

Barnes et al (1976) stated that posterior displacement of the head with intact joint capsula and synovium and blood within the capsule under some pressure tends to collapse the synovial vessels. The longer the vessels remain collapsed, higher are the chances of thrombosis and delay in revascularization process of the head. Synovial fluid constantly bathing the fracture surfaces are less responsive to normal endosteal healing process of the fracture. With all above factors, revascularization of head is delayed.

Anderson in 1979 stated that vascular damage caused by femoral neck fracture is the major factor in avascular necrosis of the femoral head. In impacted and non-displaced fracture damage occurs to intra-osseous vessels at fracture site whereas displaced fracture leads to varying degree of damage to retinacular vessels, in addition to intra-osseous vessels. Additional vascular

damage is also produced at the time of reduction but it is more when head is displaced or rotated.

The relationship of avascular necrosis with alignment of fracture fragment after reduction -

After the union of fracture avascular necrosis usually presents as segmental collapse of the femoral head. This collapse is definite indication of avascular necrosis but there are other changes as well, indicative of avascular necrosis of the femoral head.

Barnes (1962) claimed in his study that ischemic necrosis cannot be excluded on radiological grounds before twenty four months. This is true if recognition is based on structural changes in capital fragment. However, other signs manifest earlier, which are reliable but not constant. He found flatening of the weight bearing area of head to be an early radiological sign while in others condensation or collapse was the early feature of avascular necrosis.

Bunata et al (1959) suggests that a valgus reduction increases the percentage of avascular necrosis, if the valgus is sufficient to allow the parallel trabeculae in the head of the femur (as an extended line) to fall medial to the femoral shaft. Extreme valgus reduction should be avoided and varus reduction is not acceptable.

Garden in 1966 proposed an index for acceptable reduction using the trabecular pattern alignment as viewed in both antero-posterior and lateral roentgenographic planes. This has been referred to "Garden alignment index". In antero-posterior view, the angle formed by the central axis of the medial trabecular system in the head fragment and medial cortex of the femoral shaft should measure not smaller than 160° and not greater than 180°.

An angle smaller than 160° denotes unacceptable varus reduction and angle more than 180° indicates severe valgus reduction, which increase the risk of avascular necrosis and non-union. On the lateral view, Garden alignment index should again be within 20° of normal 180° straight line along neck. If this angle is more than 20°, the femoral head is anteverted or retroverted, then an unstable anatomic reduction is present and chances of non-union and avascular necrosis may increase.

Frangakis (1966) also stated about the accuracy of reduction. He stated that valgus malposition was assessed by measuring in antero-posterior radiographs of hip by Garden alignment index. An angle of 165° was considered to be the normal relation between head and neck in this plane and was taken as neutral position. Anything above this angle was measured as the degree of malposition. Fixation in more than 20° valgus malposition has a catastrophic effect on the viability of the head.

On the contrary, Wm Minar Deyerle (1965) recommended valgus reduction and described the advantage of valgus reduction. Valgus reduction shortens the neck and decreases the lever arm of proximal fragment which decreases the amount of motion at fracture site. The distal fragment is placed under the proximal fragment and provides a bony support that converts the oblique fracture line to one of contact compression. The irregular surfaces of fragments invaginated into each others provide point of fixation.

However, Barnes et al (1976) reported 29% incidence of late segmental collapse in 240 cases of united femoral neck fractures in women which were internally fixed with Garden angle greater than 180° but this incidence decreased to 25% in 223 united femoral neck fractures in women when fractures were fixed internally with Garden angle less than 180°. Acceptance of a varus reduction does not seem to influence the incidence of union. Although a slight degree of varus may be acceptable in some fractures treated by internal fixation. No fracture which was impacted in varus progressed to union in a series of impacted fractures and varus reduction has been almost equally overwhelming to those internally fixed.

Frangakis said that rotation in horizontal plane (the normal angle between centre lines of head and neck in lateral view is 180°) have no significant effect on the

incidence of ischemic necrosis. He also stated that strenuous and careless manipulation may cause further damage to blood vessels already done by the original injury which is a high price for perfect reduction.

The variety of factors contributing to the problems of non-union and late segmental collapse has been grouped by Lowell, J.D. in 1966 as follows :

1. The radiographs and their interpretation,
2. Gentleness of reduction,
3. Accepted position of reduction,
4. Posterior neck comminution,
5. The choice of fixation device.

Treatment of femoral neck fracture -

Fracturesneck femur have always presented great challenge to orthopaedic surgeons and remain in many ways even today, the unsolved fracture as far as treatment and result is concerned. Adequate reduction, impaction and rigid internal fixation constitute an essential part in solving this fracture.

Von Langenbeck (1850) was first who did internal fixation in cases of femoral neck fracture. Nicolasyen (1897) and Hey Groves (1916) used various materials for internal fixation but because of incompitability or material failure, the process of internal fixation fell

into some disrepute. Whitman (1904) after the introduction of roentgenograms suggested careful closed reduction followed by hip spica immobilization. This produced few satisfactory union but higher morbidity and mortality.

Smith Peterson (1931) is credited for reviving and popularising the procedure of internal fixation for femoral neck fractures by introducing triflanged nail and reported lower rate of mortality and morbidity from 75% to 25% and increasing the rate of union from 30% to 70%.

The revival in the treatment of fracture neck femur by internal fixation was made practical by -

(i) development of efficient apparatus for internal fixation,

(ii) The development of non-electrolyte metals after the experimental work of Venable, Stuck and Beach (1937).

(iii) The projection of more efficient roentgenographic control.

In young patients where anatomical restoration of femoral head and neck is not possible, treatment by osteotomy and osteosynthesis is often advocated. Several types of osteotomy have been described (Mc Murray, 1936; Reich, 1941; Blount, 1943; Leadbetter, 1944). These operations help to stabilize the hip but union of the

fracture does not always occur and sometimes hip remains painful and function is unsatisfactory (Hermann, 1945; Reynolds & Totto, 1951; Dickson, 1953; Stewart & Well, 1956).

Osteosynthesis of the femoral neck fracture using a tibial or a fibular graft and Smith-peterson nail (King, 1939) have been advised for the patient where fracture was less than three months old, provided that the femoral head was vascular and not much of the neck has been absorbed. Dickson (1953) said that sometimes insertion of cortical graft across the fracture site disimpacts or angulates the head which in turn lead to unsatisfactory healing and non-union.

These procedures were not good for Garden type III & IV fractures and total failure rate including non-union and subsequent avascular necrosis was 70.9% in displaced fractures as shown by Frangakis in 1966.

Inclan (1946) and Patrick (1944) also published their results of Smith-Peterson nailing and fibular grafting, reporting 10% to 15% of non-union and avascular necrosis.

There is lot of confusion and controversy regarding the treatment of femoral neck fracture, especially in comparison with primary prosthetic replacement and internal fixation and if internally fixed then over method of internal fixation. Recently emphasis is given to

preserve the head because viable head work definitely better than prosthesis. Over it Bracey (1977) commented that those fractures if reduced accurately, definitely did better.

Keeping the above problem in mind, many workers devised various methods of treatment from time to time for femoral neck fractures with the general agreement that anatomical reduction, impaction and rigid internal fixation of displaced femoral neck fractures are the basic requirements for treatment of fracture neck femur.

The workers have used different methods of internal fixation such as Triflanged nail by Smith-Peterson (1931), Austin Moore pins, Knowel's pins, Henery screw, Henderson lag screw, Sliding nails of Pugh. More recently other type of apparatus such as cross screw of Garden (1964), Triangle fixation by Smyth (1964), Deyerle's apparatus which consist of multiple threaded pins and a plate attached to lateral side of the femoral shaft (1965), compression collapsable appliances by Calandruccio & Richards; posterior bone grafting combined with internal fixation by Meyers (1974) and Percutaneous multiple pin fixation by Neufield (1973), Arnold (1984) & many others.

Deyerle observed that area of neck is of critical importance because large portion of the blood supply to heal the fracture and maintain the viability of head must come through this area. The area of the neck is 1¼ inch

in diameter. Each ⅜ inch pin takes up 1% of its cross section while a cannulated triflanged nail takes up 6% of the neck area, the equivalent of 6⅜ inch pins. Two ¼ inch lag screws take up 8% of the area of the neck. 7 pins take 7% area. The recommended fixation in neck fracture is 7 pins. 7% of the area of the neck is not a very great sacrifice to obtain absolute fixation and thereby to avoid further trauma to the budding young blood vessels that must grow across the fracture.

With a triflanged nail, it is comparable to brakes applied to the axle while with multiple peripheral pins, it can be likened to brakes applied to the peripheral drum. The stress is applied to a large surface area of trabeculae over or 1 inch area with peripheral pins and is applied to a small 7/16 inch area with triflanged nail or any nail of comparable size. The 6 peripheral pins have 2-3 to 4 times the leverage of triflanged nail.

He also compared the resistance to motion by triflanged nail to Smith-Peterson nail and he found that resistance to motion with seven pins fixation would be 20 times that with a triflanged nail. He also concluded that fixation is directly related to surface area of contact and the dispersal of the area of contact.

He also summarises the importance of absolute fixation (rigid fixation) as follows -

1. Repeated trauma of fracture surface is avoided.

2. Repeated inflammatory reaction at the fracture site with decalcification of the neck and fibrosis of the fracture surfaces that may block revascularization.

3. Fracture unites sooner and thus the femoral head is less likely to become avascular.

In Deyerle's initial series of 75 fractures, he reported avascular necrosis in 8% and no non-union, but Metz et al in 1970 reported in 63 patients with displaced femoral neck fracture treated by Deyerle's method, found that union occurred in 94% and avascular necrosis in 6%.

Chapman et al (1975) and Ryan associates (1979) however found higher incidence of non-union and avascular necrosis.

With the recent advance in knowledge of injuries and diseases of hip and especially with great increase in the incidence of bony union following pinning and wiring of fresh fractures aseptic or avascular necrosis of the head of the femur has come to be recognized as one of the most important and perplexing problems which confront the orthopaedic surgeons.

Fracture of the neck of femur unites early if head remains alive. This is because there is callus

formation from the end of each fragment when the head survives but only from the end of distal fragment when proximal or head fragment dies.

To overcome the problem of poor vascularity, Helstadius (1942) came up with the idea of muscle pedicle grafting with its vascularity intact. Stuck (1944), Francle (1952), Hartley (1954) and Davis (1958) showed survival of the bone portion of the muscle pedicle grafts in animal experiments.

Baadsgaard and Medgyesi (1965) showed that pedicle cancellous grafts in rabbits survived with numerous vessels present deep in the bone graft from the periosteum. Medgyesi (1968) reported that in pedicled cortical bone grafts majority of the osteocytes perished but the blood supply and osteogenic ability of the bone persisted. He also stated that for the viability of pedicle graft, following factors play role -

1. Graft should be handled atraumatically,
2. No torsion of pedicle,
3. There should be no flexion and extension.

Stuck and Hinchey (1944) reported improved circulation in the femoral head in osteo-arthritic hip after transplanting a muscle pedicle graft into the neck of the femur in humans.

Davis and Taylor (1952) in their experimental study on dogs showed that if the muscle pedicle was of sufficient width, not too long and not stretched or twisted, periosteal attachment of the muscle to the bone was retained, the cut surface of attached bone graft continued to bleed and in all favourable condition a cancellous bone graft retains its viability when it is transplanted with a muscle belly pedicle which leaves its periosteal blood supply intact in comparison to the cancellous grafts transplanted without pedicle.

Frankel & Derine (1962) reported that autogenous muscle pedicle graft of the gluteus medius and vastus lateralis in dogs were capable of restoring the blood supply to the femoral heads which had been made avascular experimentally.

Launois & Judet (1963) described a similar experiment in dogs, which was carried out by means of an autogenous muscle pedicle bone graft of the quadratus femoris muscle. In 1962 Judet reported a clinical use of muscle pedicle graft of the quadratus femoris muscle as a means of improving the blood supply of head fragment in displaced femoral neck fractures.

In a retrospective study of 250 displaced subcapital fractures treated at the Los Angeles County University of Southern California Medical Centre from 1960 to 1965, an incidence of non-union in 35% of the cases and

late segmental collapse in 32% of the cases was found. A significant improvement in these results was noted following introduction of the muscle pedicle graft procedure. In 144 cases treated since July 1971 with a standardized technique reveals that the rate of union is 95% and late segmental collapse has occurred in 5% of the cases that united. It is impressive that in this series, all but one of 23 patients in the young adult group under the age of 40 have united and to date there has been no radiologic evidence of late segmental collapse. The latter result is a remarkable achievement considering the discouraging reports in the literature on the treatment of displaced subcapital femoral neck fractures in patients under the age of 40.

Meyers and Harvey (1974) reported that muscle pedicle bone grafting procedure gives encouraging results in old and delayed or non-union of fracture neck femur.

Nine year later, Baksi (1983) reported encouraging results in the treatment of post traumatic avascular necrosis of the femoral head whether the fracture was united or not. Later same author (Baksi, 1986) did internal fixation of un-united fracture of femoral neck combined with muscle pedicle bone grafting and evaluated encouraging results.

The posterior bone graft (muscle pedicle) was improved the incidence of union and lowered the rate of late segmental collapse. The muscle pedicle graft improves

the blood supply to the head fragment when it is impaired, thus reducing the incidence of late segmental collapse. A higher rate of union is a result of better fixation and restoration of continuity to the posterior comminuted portion of the neck since a posterior intra-capsular approach is required to carry out the procedure.

In addition to providing a source of blood to the head fragment when the fracture interrupts the blood supply either totally or sub-totally, the operation has many advantages.

Since it is necessary to approach the fracture site posteriorly and intra-capsularly, direct visualization of the posterior neck of the femur is obtained. A more accurate reduction of fracture can be realized under direct view. Iliac bone chips and chips from greater trochanter can be added to fill the defect in the posterior neck of the femur, which has been found in 70% of the fractures. Improved fracture stability is provided by the pedicle graft. The latter acts as a neutralization force since it is fixed to the posterior surface of the neck which is compression side of the fracture.

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MATERIAL AND METHODS

MATERIAL AND METHOD

Twenty cases of fracture neck femur, both fresh as well as un-united or neglected, attending orthopaedics out-patient department and emergency department of M.L.B. Medical College Hospital, Jhansi, were thoroughly examined clinically, radiologically and treated by open reduction and internal fixation with multiple Austin Moore's pins, bone grafting and muscle pedicle bone grafting.

Criteria for selection of cases -

All the cases of fracture neck femur except at extremes of age, constituted the subjects of this study with following exceptions.

1. Inability to walk due to causes other than fracture.
2. Those unable to co-operate in the post-operative programme because of senility, psychosis, mental retardation, perkinsonism, or cerebro-vascular accident with residual hemiplegia and spasticity.
3. The patients with poor health who can not withstand two major operation, in these cases prosthetic replacement may help.
4. Those with life expectancy of less than 2 years (such as malignant disease).

METHOD -

The patients were thoroughly examined clinically and radiologically & relevant findings recorded in the proforma as below :

Case No. :

M.R.D. No. :

Name of patient :

Father's/Husband's name :

Age/Sex :

Address :

Occupation :

Date of admission :

Date of discharge :

CHIEF COMPLAINTS

History of present illness :

- Date of injury :
- Mode of injury :
- Time lapse between injury and first treatment taken (immobilization)
- H/o unconsciousness, vomiting etc.
- Other complaints
- Associated injury
- Treatment taken

Past History :

Family History :

General Examination :

- Appearance
- Built
- Pulse rate
- Blood pressure
- Respiratory rate
- Pallor
- Icterus
- Cyanosis
- Clubbing
- Oedema
- Lymphadenopathy

Systemic Examination :

- Abdomen
- Cardiovascular system
- Respiratory system
- Central Nervous System.

Local Examination :

- Side - right / left / both
- Simple / compound
- Abrasion / Contusion
- Attitude
- Deformity
- Telescoping
- Shortening (True)
- Upward shift of greater trochanter
- Range of movements
- Wasting of Quadriceps
  (at 20 cm above the knee joint line)

Investigations :

Blood
- Total Leukocyte count
- Differential leukocyte count

  P L E M
- Erythrocyte sedimentation rate
- Haemoglobin
- Blood sugar - F
  - PP
- Blood urea

Urine
- Albumin
- Sugar
- Microscopic examination

X-ray
- Site - Subcapital / Transcervical / Basal
- Absorption of neck
- Sclerosis at fracture site
- Proximal migration of greater trochanter (Upward shift)
- Avascular necrosis of femoral head
- Changes in acetabulum.

MANAGEMENT

I- First aid management
- Absolute rest
- Long Liston's splint
- Skin Traction A/K / B/K
- Skeletal traction
- Skin traction & limb kept on Thomas' splint.

II - Definitive management : Already done before admission.

a) Conservative

- By traction
- POP hip-spica

b) Operative

- S-P Nailing
- Multiple pinning
- Mc Murray's osteotomy

III - Present management

- Open reduction with internal fixation with multiple pinning with muscle pedicle bone grafting.

OR

Open reduction with internal fixation with multiple pinning with muscle pedicle bone grafting with multiple drill holes.

- Site from where the graft were taken.

Post-operative Management :

- Nature of immobilization in post-operative period.
- Date of mobilization.

Check X-ray :

- Good / Satisfactory / Unsatisfactory
- Alignment at fracture site
- Coxavara / Coxavalga
- Anteversion / Retroversion
- Position of muscle pedicle bone graft
- Position of pins

Condition of wound

- Haematoma
- Superficial infection
- Deep infection

Date of discharge

Nature of immobilization at the time of discharge

Total period of hospitalization

Follow-up :

At 2 month

- Condition of wound
- Presence of pain
- Signs of union on X-ray
- Signs of non-union on X-ray

At 3 months

- Condition of wound
- Presence of pain
- Signs of union on X-ray
- Signs of non-union on X-ray
- Ability to lift the limb against gravity
- Ability to walk unsupported
- Ability to walk with crutches
- Limb length discrepancy
- Range of movements
- Quadriceps wasting
- Evidence of avascular necrosis of femoral head.

At 4th, 5th and 6th months

- Condition of wound
- Presence of pain
- Signs of union on X-ray
- Signs of non-union on X-ray
- Ability to lift the limb against gravity
- Ability to walk with crutches
- Ability to walk unsupported
- Limb length discrepancy
- Range of movements
- Quadriceps wasting
- Evidence of avascular necrosis of femoral head
- Ability to squat
- Ability to sit cross legged.

Final Results :

- Good / Satisfactory / Poor.

Operation :

Anaesthesia - General anaesthesia or spinal analgesia.

Position - Prone position on fracture table with feet fixed to foot plates.

Approach :

Moore's approach with some modifications was used. Incision starts about 10 cm distal to the posterior superior iliac spine extending distally and laterally with the fibres

of gluteus maximus upto the tip of greater trochanter, extending distally to the lateral aspect of greater trochanter, vertically downward on lateral surface of thigh for about 10 to 12 cm. Gluteus maximus muscle splitted in direction of its fibres. The underlying fat and sciatic nerve reflected medially. The quadratus femoris identified and limb rotated internally, the rectangular graft is marked out on the inter-trochantric crest of femur, starting at a point about 3 cm. from the tip of greater trochanter along the postero-lateral aspect of inter-trochantric crest for a distance of entire width of quadratus femoris, about 1.5 to 2 cm. broad and 1 to 1.5 cm. thick. To minimize the chances of breaking the graft, it is outlined with drill holes through posterior cortex of femur and these drill holes are then be connected using osteotome. The graft thus outlined is undermined with curved osteotome. Medial edge of graft should be at the base of neck of femur and outside the capsule.

After the bone graft has been undercut with curved osteotome, the graft with attached quadratus femoris muscle is freed with a large osteotome and retracted in the direction of the muscle's origin on the lateral aspect of the ischial tuberosity.

Evidence of circulation on cancellous surface of bone graft as well as in the substance of attached quadratus femoris muscle was always noted. This was seen

by free oozing on cancellous surface of bone graft and the muscle maintained the reddish appearance of normal muscle.

After preparation of graft, rotators of hip were cut and retracted medially and inverted T incision is then made in the posterior part of capsule, the stem of which starts at the acetabular labrum and ends at the femoral attachment of capsule. The cut ends of capsule was retracted and posterior aspect of the head is readily seen. In old untreated un-united fractures, fracture surfaces were cleared of fibrous tissue and any tags of periosteum; their sclerosed surfaces were then freshened. A tilt or rotation of femoral head was corrected. Multiple drill holes were made in femoral head to decompress the necrotic bone. The fracture surfaces were reduced and fixed in a position of 20° internal rotation.

The fracture was then fixed internally by Moore's pins. Usually we used 3 or 4 Moore's pins. Free cancellous bone grafts, taken from iliac crest or greater trochanter were packed between the fracture surfaces. Pins should be parallel to each other to provide good fixation. Muscle pedicle bone graft was attached to the gutter made on posterior surface of head and neck without any tension or torsion with the help of stapple.

The common tendon of obturator internus and gemelli was again reattached to its original insertion

and quadratus femoris muscle fibres to provide graft with additional security. Wound closed in layers.

Post-operative treatment -

Part is immobilised by long Liston's splint in post-operative period upto the removal of stitches. After the removal of stitches, a hip spica was applied for 2 - 4 months, but in some patients where fixation was secure, no immobilization was given and patient was kept freely mobilized in bed.

Criteria for the perfect reduction are the Garden's alignment index, utilising standard radiographic views. The normal angle between the medial trabeculae of the femoral head and the medial cortex of the femoral shaft is 160 degree. The central axis of femoral head and neck in the lateral views normally be in straight line, i.e. 180 degree. A perfect reduction can then be called as an alignment index (A.P. angle / Lateral angle) of 160 degree/ 180 degree. Reduction producing an angle of 155 degree to 180 degree in each view should be considered acceptable. It is associated with a relatively higher rate of union and low incidence of avascular necrosis.

Follow-up -

Patients were followed at 2 months and then every month for 6 - 12 months.

I. Clinical assessment -

At 2 month - Condition of wound,

- Presence of pain.

At 3 month - Condition of wound,

- Presence of pain,
- Ability to lift the limb against gravity,
- Ability to walk unsupported,
- Limb length discrepancy,
- Range of movements,
- Quadriceps wasting.

At 4th, 5th and 6th months -

- All above criteria with ability of patient to walk with crutches or unsupported.
- Ability to squat and sit cross-legged.

II. Radiological assessment -

was done at regular intervals of 1 month to see -

1. Whether fixation was secured,
2. Stage of union at fracture site,
3. Extrusion of pins,
4. Any evidence of absorption of neck of femur,
5. Any sign of segmental collapse or avascular necrosis.

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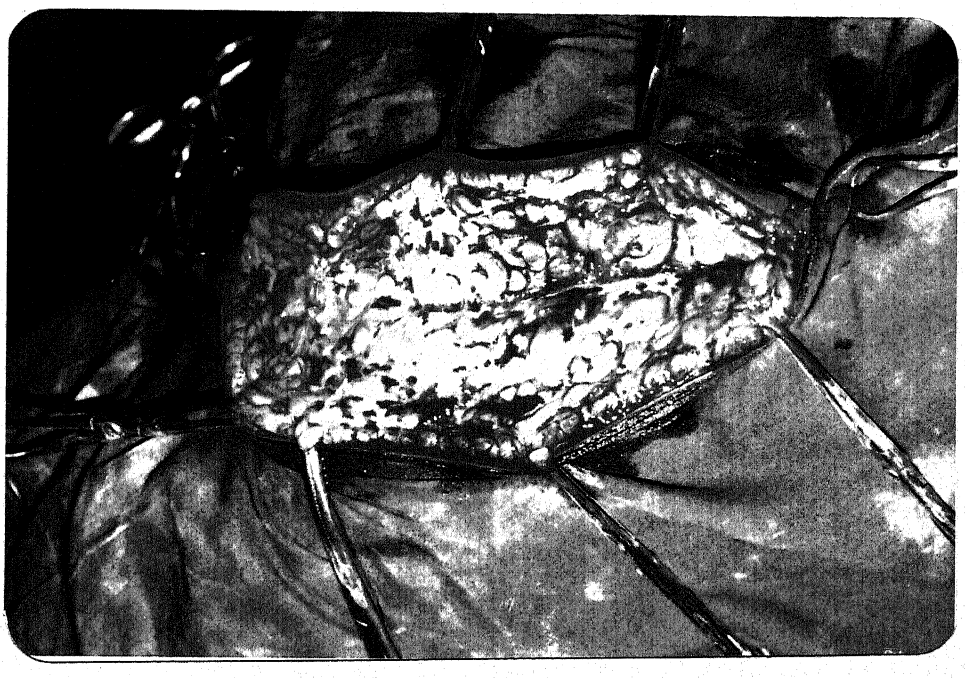
Operative Steps



Photograph - 1

Showing skin incision.

Photograph - 2

Showing Quadratus Femoris Muscle.

Photograph - 3

Showing Muscle pedicle graft (Quadratus Femoris Muscle) with donor site.

Photograph - 4

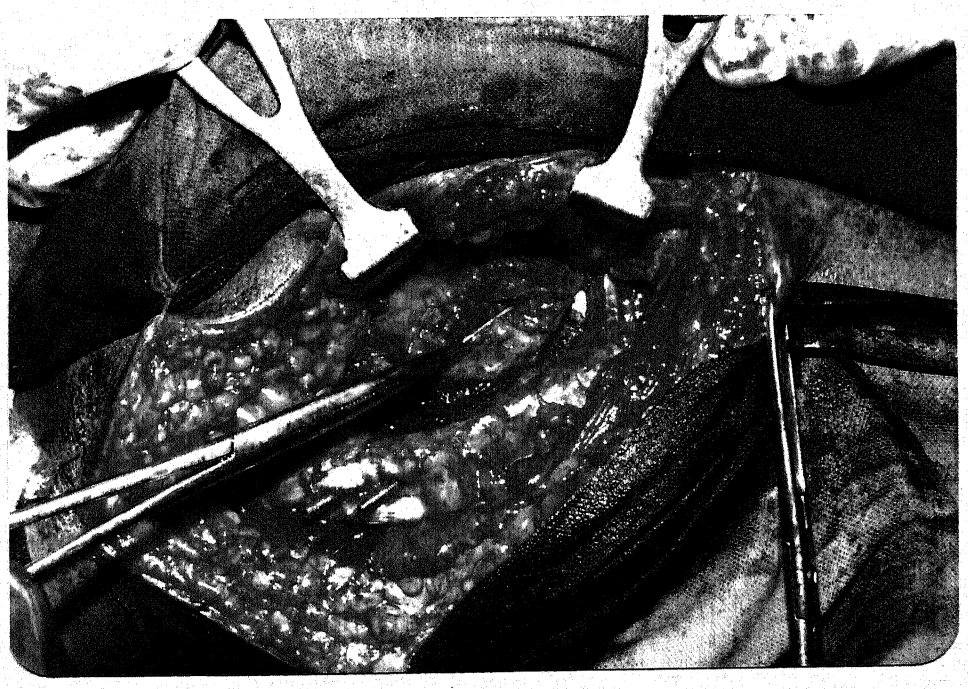
Showing cancellous bone grafts taken from greater trochanter.

Photograph - 5

Showing sclerosed head of femur.

Photograph - 6

Showing multiple drill holes made in femoral head.



Photograph - 7

Showing fractured fragments fixed with Moore's pins and muscle pedicle graft fixed with staple.

OBSERVATIONS

OBSERVATIONS

The present study has been carried out in the department of Orthopaedics, M.L.B. Medical College, Jhansi. Twenty (20) cases of femoral neck fractures, fresh as well as ununited or neglected in all the ages except extremes of ages were treated by open reduction, internal fixation by Austin Moore's pins with muscle pedicle bone grafting.

Table I

Showing incidence of age.

Age group in years	No.of cases	Percentage
∠ 20	3	15
20 - 30	9	45
30 - 40	3	15
40 - 50	2	10
50 - 60	3	15
* 7 60	-	-
Total	20	100

* Patients beyond the age of 60 years were not included in this study.

Table II

Showing sex incidence.

Sex	No. of cases	Percentage
Male	14	70
Female	6	30
Total	20	100

Fracture neck femur occurs at all the ages (Table I). In the present study, age varied from 14 to 60 years. Average age being 3 years. Majority of these cases were males (Table II).

Table III

Showing grading of fracture according to Garden's Classification.

Grade	No. of cases	Percentage
I	1	5
II	1	5
III	16	80
IV	2	10
Total	20	100

Table III shows the severity of fracture according to Garden's classification. 90% of cases have grade III (80%) and Grade IV (10%) fractures.

Table IV

Showing incidence of associated diseases and injuries.

Associated Diseases/ injuries	No.of cases	Percentage
Post Polio residual paralysis	1	5
Pott's spine	1	5
Colles's fracture	1	5
Total	3	15

One case had post polio residual paralysis in the same limb and there was shortening even before injury, however, there was no fixed deformity.

One case had severe kyphosis in dorsolumbar region and was unable to lie supine in the bed.

Third case has associated Colles's fracture which did not interfere in any way in the treatment of femoral neck fracture.

Table V

Showing definite treatment received by patients prior to muscle pedicle bone grafting.

Type of treatment received	No.of cases	Percentage
Mc Murray's osteotomy	2	10
Total	2	10

Majority of the cases, both fresh as well as ununited, were the cases who had not received any treatment for femoral neck fractures. Only 2 patients had undergone Mc Murray's osteotomy where the osteotomy had united but femoral neck fracture remained ununited.

Table VI

Showing the time elapsed between fracture and operation.

Time	No.of cases	Percentage
∠ 3 weeks	10	50
3 weeks to 3 months	5	25
7 3 months	5	25
Total	20	100

50% of our cases were the fresh cases as they could be operated within 3 weeks of injury. Rest of them were neglected fractures. The duration being 3 weeks to 2 years.

Table VII

Showing per-operative findings.

Per-operative findings	No.of cases	Percentage
Comminution of posterior cortex	14	70
Inter position of capsule	5	25
Sclerosis at fracture site	7	35
Absorption of neck	4	20

Open reduction was done and majority of cases had comminution of posterior cortex or soft tissue interposition. 70% of cases had comminution of posterior cortex of femoral neck whereas interposition of the capsule at fracture site present in 25% of cases. However, old neglected cases had absorption of neck and/or sclerosis at fracture site as well.

Table VIII

Showing quality of reduction achieved.

Quality of reduction	No.of cases	Percentage
Good	15	75
Satisfactory	4	20
Unsatisfactory	1	5
Total	20	100

Good anatomical reduction could be achieved only in 75% of cases. Slight coxa valga (upto 20°) was considered as a satisfactory reduction. In one case however, reduction could not be achieved.

Posterior comminution when present often posed difficulty to achieve anatomical reduction. The main problem faced was to keep the femoral head reduced, as there was no hold on the femoral head and it used to rotate with the strike of Austin Moore's pins. This problem occurred only with the first pin and occasionally (in two cases) with the second pin as well.

Table IX

Showing the quality of fixation.

Fixation	No. of cases	Percentage
Secured	19	95
Unsecured	1	5
Total	20	100

Post operative X-ray showed secured fixation in 95% of cases. In one (5%) case, fixation was not secured as the pins just cross the fracture site for about 1 - 1.5 cm. in femoral head. Any how, the second follow-up X-ray showed loss of fixation, as well as reduction and finally she had poor results.

Table X

Showing effect of fixation on union.

Effect of fixation	Secured fixation		Unsecured fixation	
	No.	%	No.	%
United	17	85	-	-
Ununited	2	10	1	5
Total	19		1	

Secured fixation was pre-requisite for the union of the fracture as one case who had unsecured fixation ultimately landed in non-union and 17 out of 19 cases with secured fixation had good union. Two cases, however, went in non-union inspite of secured fixation. One of whom had undergone Mc Murray's osteotomy earlier and ultimately avascular necrosis of femoral head occurred. Other case of non-union was that in which reduction could not be achieved.

Table XI

Showing donor site for cancellous bone grafts.

Site of bone grafts	No.of cases	Percentage
Greater trochanter	14	70
Iliac crest	6	30
Total	20	100

Bone grafts were taken from greater trochanter as there was no need for a separate incision and did not lengthen the operative time. In 30% of cases where there was marked absorption of neck and good amount of grafts were needed, grafts were obtained from iliac crest.

Table XII

Showing post-operative management.

Post-operative management	No.of cases	Percentage
POP hip spica	7	35
Liston's splint followed by crutch walking	13	65
Total	20	100

POP immobilization by 1½ hip spica was given in 7 (35%) of cases where there was absorption of neck or fixation was not secured or reduction was not perfect or there was infection.

Table XIII

Showing incidence of complications.

Complications	No.of cases	Percentage
Superficial infection	3	15
Loss of fixation	1	5
Avascular necrosis and collapse of head	1	5
Extrusion of pins	1	5

Complications were few in the form of superficial infection, loss of fixation, avascular necrosis and extrusion of pins. Superficial infection occurred in 3 (15%) cases which could be well controlled by antibiotics according to culture and sensitivity. One case had loss of fixation which was mainly because of technical fault. Avascular necrosis and collapse of femoral head occurred in one case, who came 2 years after injury and had earlier gone for Mc Murray's osteotomy.

Table XIV

Showing incidence of post-operative limb length discrepancy.

Limb length discrepancy in cm.	Shortening*		Lengthening**	
	No.of cases	Percentage	No.of cases	Percentage
∠ 1 cm	-	-	1	5
1 - 2 cm	3	15	1	5
2 - 3 cm	1	5	-	-
7 3 cm	1	5	-	-
Total	5	25	2	10

* Out of these five patients who had shortening, one had post polio residual paralysis and shortening of affected limb prior to injury.

- One patient had earlier undergone Mc Murray's osteotomy.
- In one patient, fixation was lost in the post-operative period and hence the reduction was lost.
- In remaining one, the perfect reduction could not be achieved on table.

** Two patients had lengthening because of valgus reduction but in both of them amount of valgus was $\angle 20^{\circ}$.

Table XV

Showing ability to walk unsupported.

Ability to walk unsupported (duration in weeks)	No.of cases	Percentage
∠ 12	-	-
12 - 16	12	60
16 - 20	3	15
20 - 24	3	15
7 24	-	-
Unable to walk unsupported	2	10
Total	20	100

Majority (60%) of patients could walk unsupported between 12 - 16 weeks after surgery. Six (30%) cases took little longer and could walk unsupported between 16 - 24 weeks. Two cases could not walk unsupported as there was non-union. One case could walk unsupported inspite of non-union and avascular necrosis of femoral head who had earlier undergone Mc Murray's osteotomy.

Table XVI

Showing ability to squat.

Ability to squat (Duration in weeks)	No.of cases	Percentage
< 12	-	-
12 - 16	3	15
16 - 20	8	40
20 - 24	6	30
> 24	-	-
Unable to squat*	3	15
Total	20	100

* Three patients out of twenty were not able to squat -

- Two of them, either the reduction could not be achieved or was lost in the post-operative period.

- One patient who had undergone Mc Murray's osteotomy earlier, developed avascular necrosis of femoral head.

Table XVII

Showing ability to sit cross-legged.

Ability to sit cross-legged (Duration in weeks)	No.of cases	Percentage
< 12	-	-
12 - 16	3	15
16 - 20	7	35
20 - 24	5	25
> 24	2	10
Unable to sit cross legged *	3	15
Total	20	100

* Two of them, either the reduction could not be achieved or was lost in the post-operative period.

One patient who had undergone Mc Murray's osteotomy earlier, developed avascular necrosis of femoral head.

Table XVIII

Period of follow-up.

Period of follow-up (in months)	No. of cases	Percentage
Upto 12	2	10
9 - 12	7	35
6 - 9	9	45
3 - 6	2	10
∠ 3	-	-
Total	20	100

Table XIX

Showing end results.

Results	No. of cases	Percentage
Good	16	80
Satisfactory	2	10
Unsatisfactory	2	10
Total	20	100

Union occurred in 85% of cases. All of whom except one were able to walk unsupported, had good range of movement at hip joint, could squat and sit cross legged and hence were graded as good result (80%). One case who had union but had restriction of adduction and internal rotation with pain at extremes of movements, but could walk unsupported, was graded as satisfactory result.

In three cases fracture failed to unite but one of them who had undergone earlier Mc Murray's osteotomy could walk unsupported and had painless range of movements, was also graded as satisfactory result. This patient was very happy as the stability of hip improved and pain was relieved.

Two cases who had non-union and could not walk unsupported were graded as poor results (10%).

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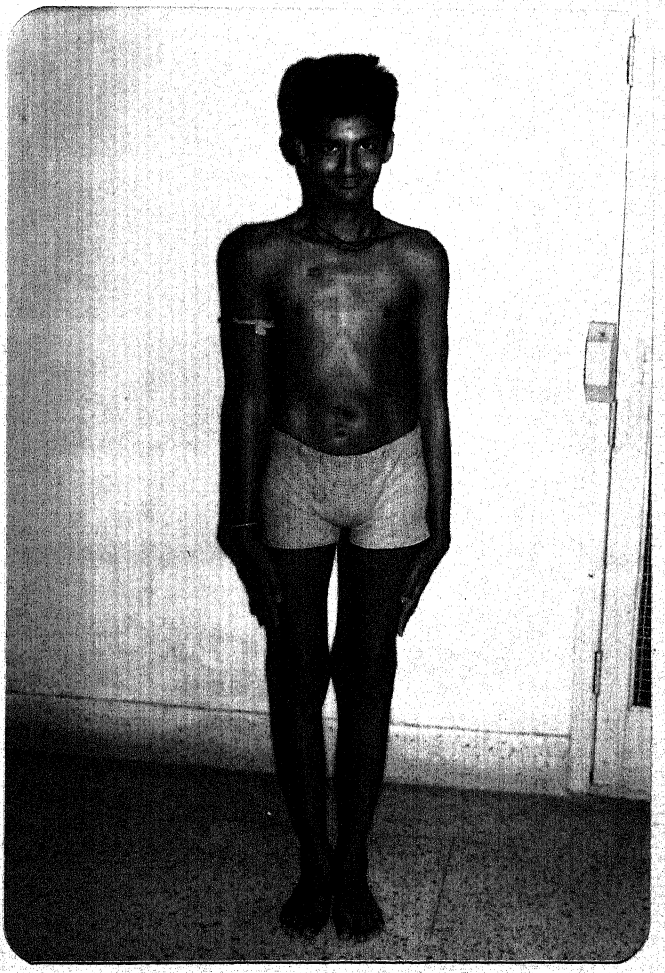
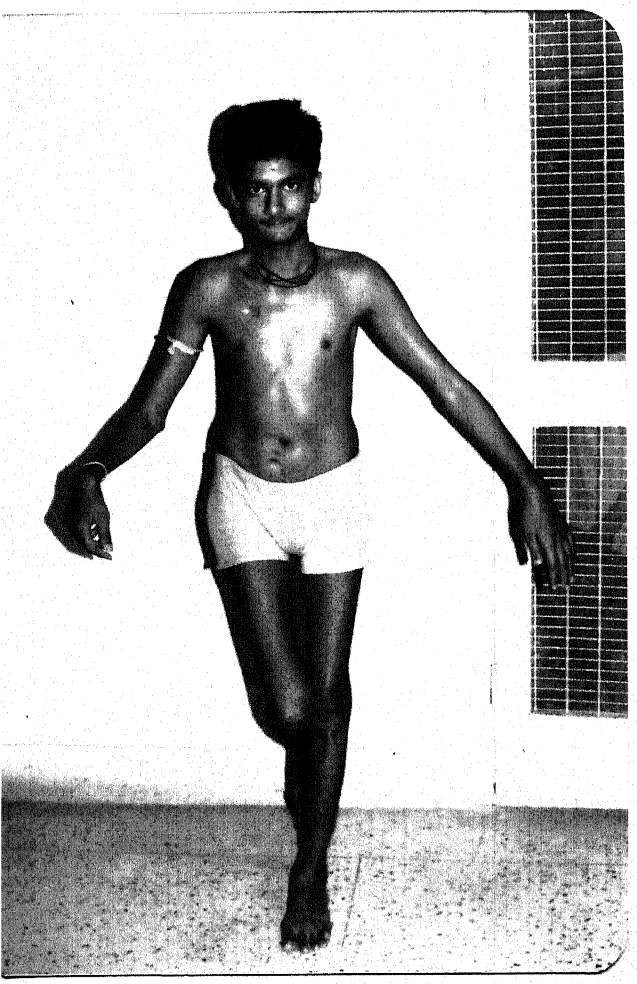
Photograph - 1

Showing healthy stitch line.



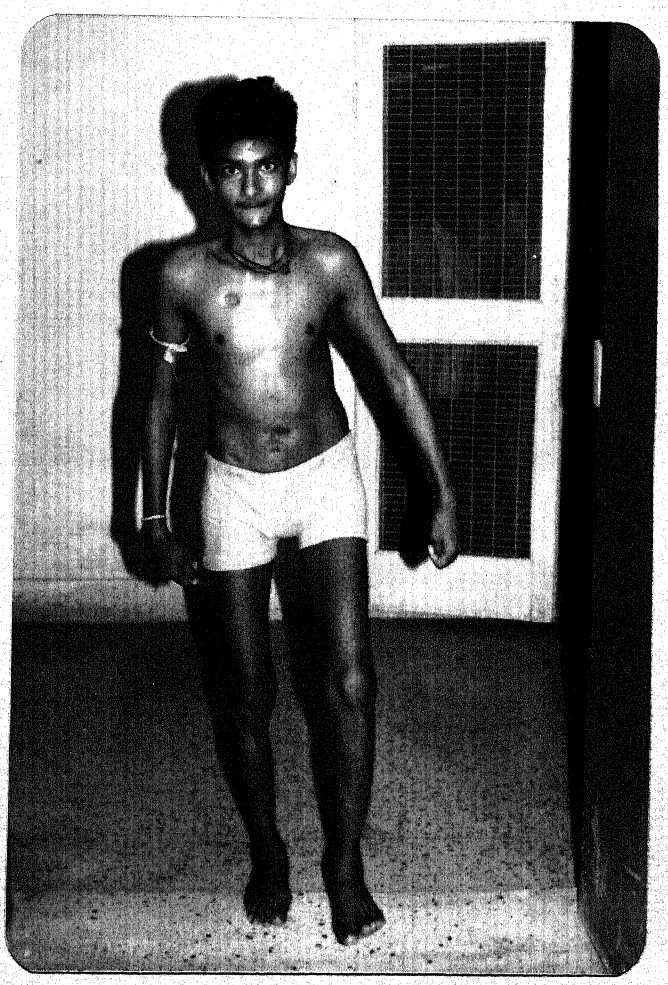
Photograph - 2

Showing the same patient in standing posture after 12 weeks of internal fixation with muscle pedicle bone grafting.



Photograph - 3

Showing the same patient standing on affected limb after 16 weeks of operation.

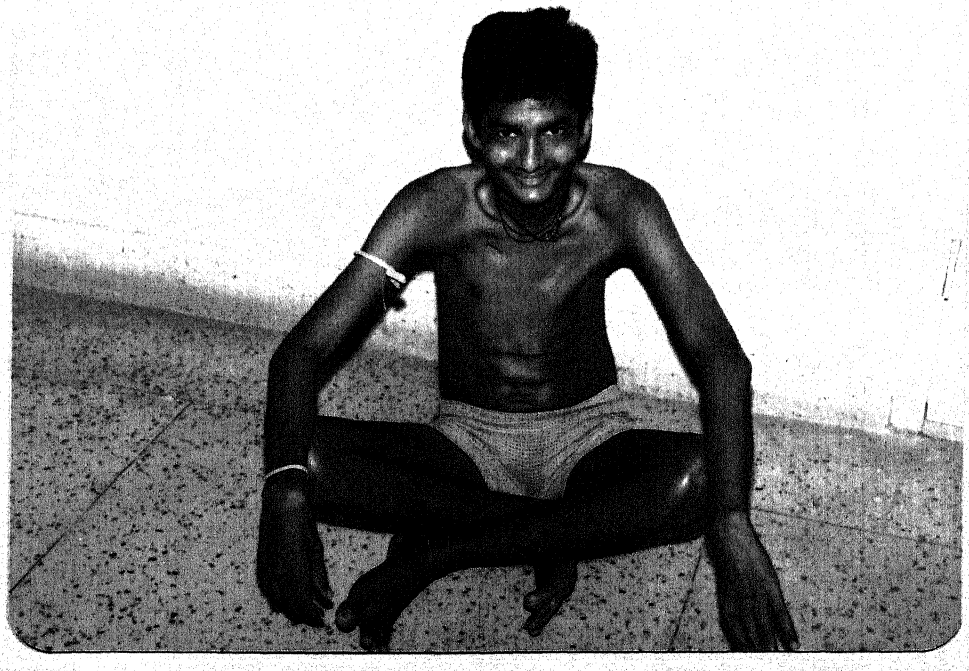


Photograph - 4

Showing the same patient walking unsupported after 16 weeks of operation.

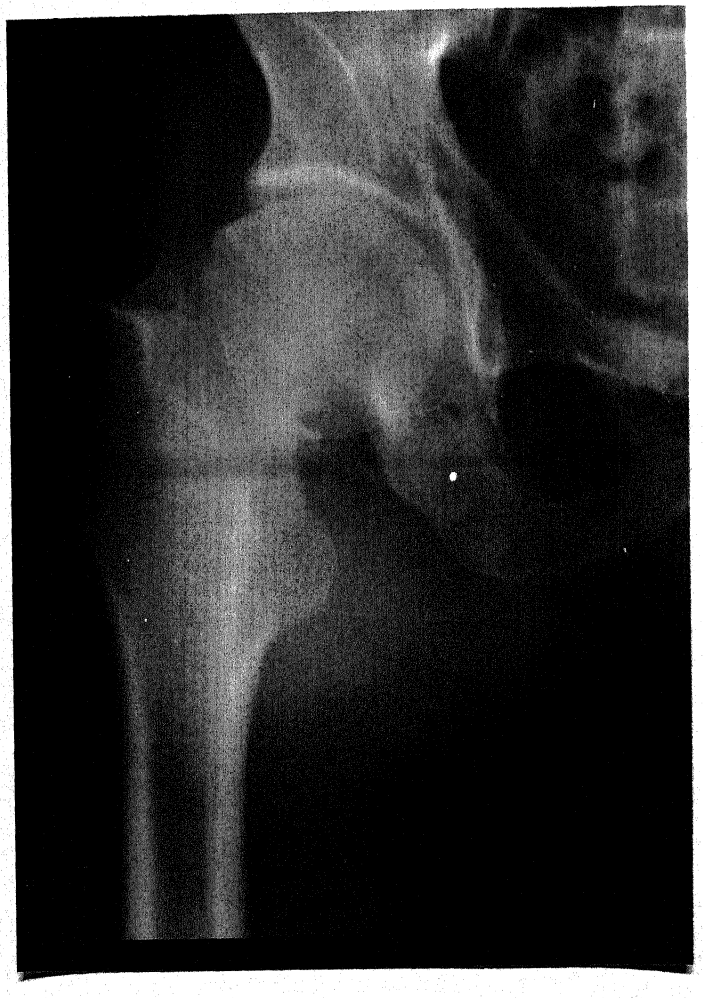
Photograph - 5

Showing the same patient in squatting posture after 20 weeks of operation.

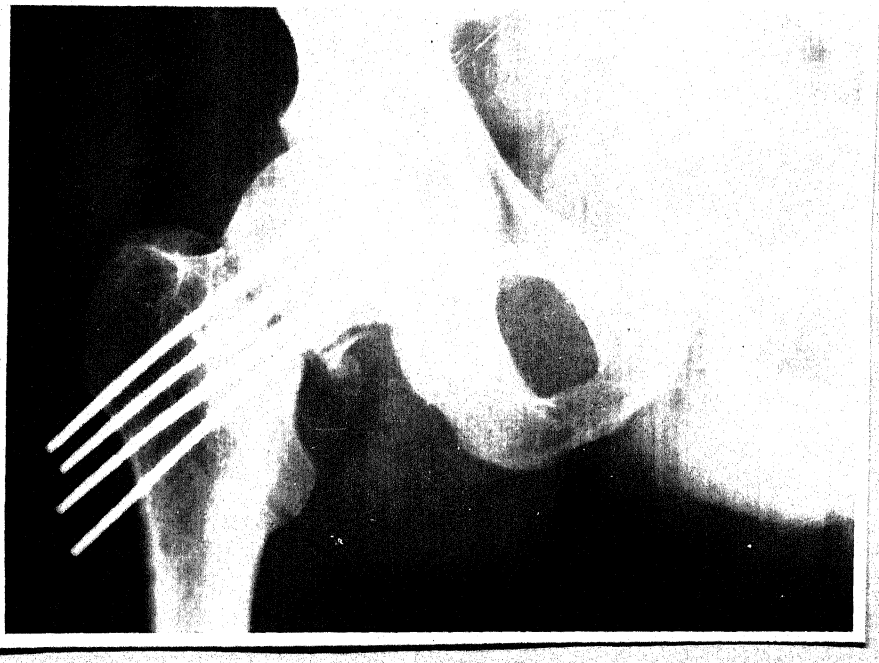


Photograph - 6

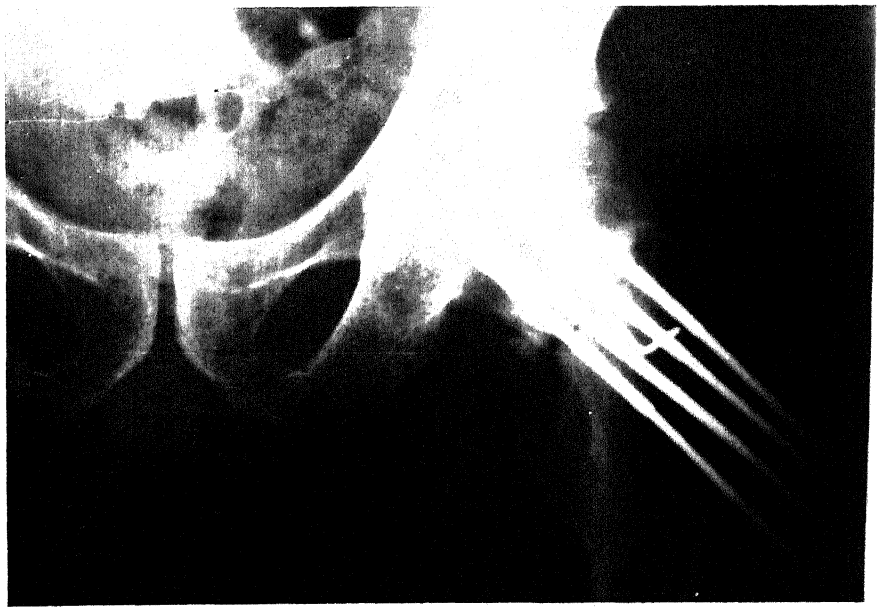
Showing the same patient sitting cross-legged after 24 weeks of operation.



Pre-operative X-ray showing intra-capsular fracture neck femur (Garden type III)

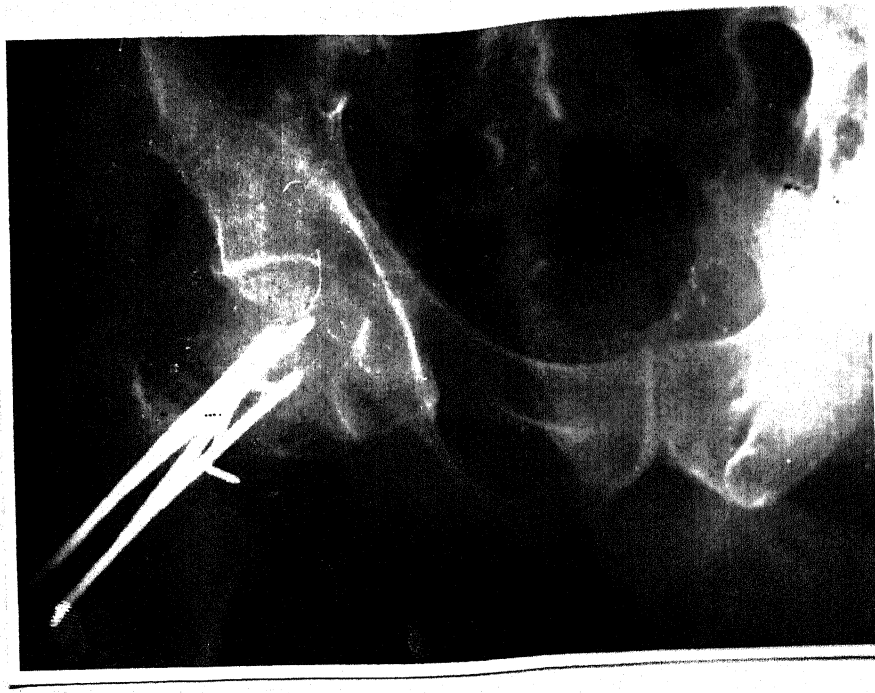


X-ray immediately after operation : showing good reduction and secured fixation.

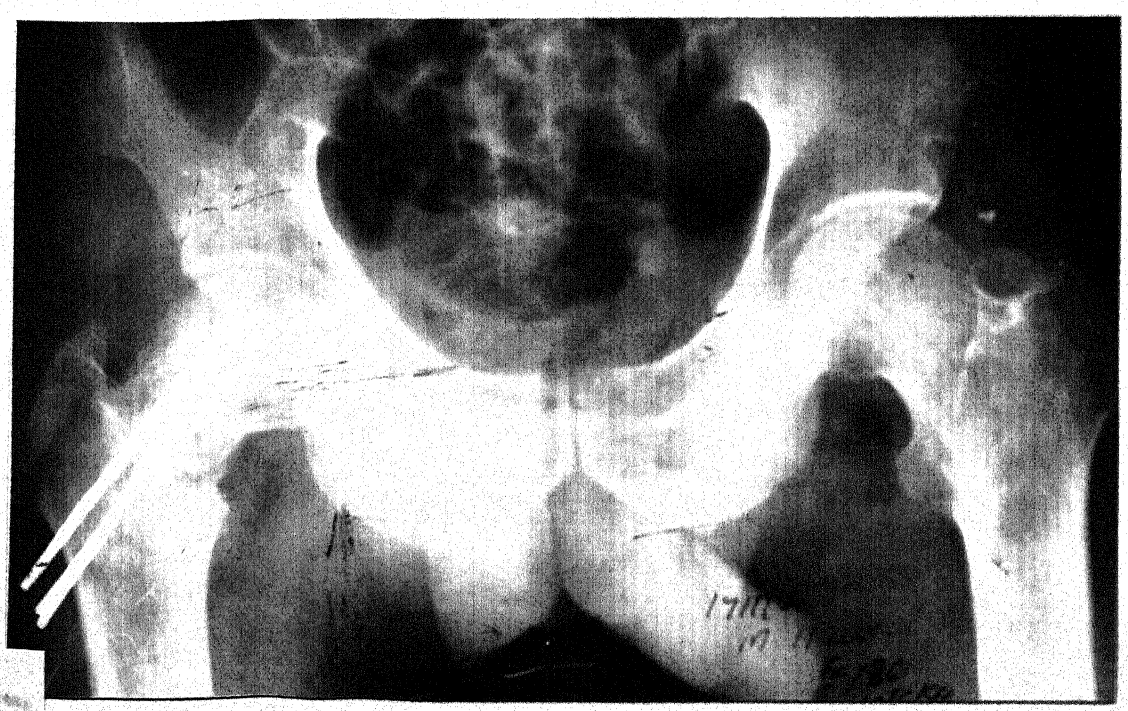


X-ray 8 weeks after operation : Showing maintained reduction and fixation with evidence of union.

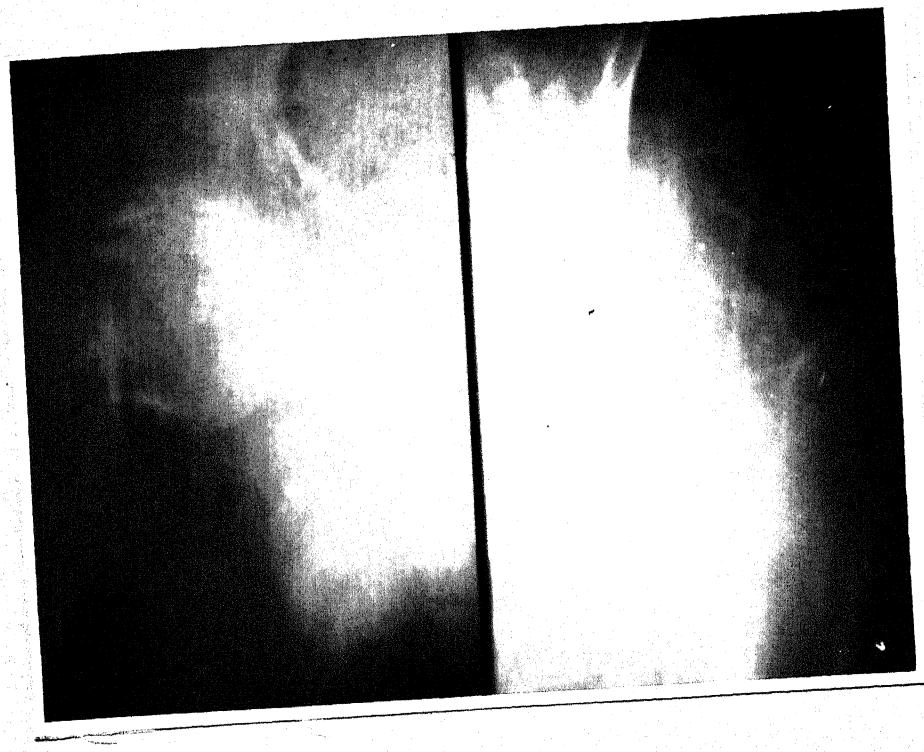
Pre-operative X-ray showing intracapsular fracture neck femur with absorption of neck.



X-ray immediately after operation : showing good reduction, secured fixation with reconstruction of neck.

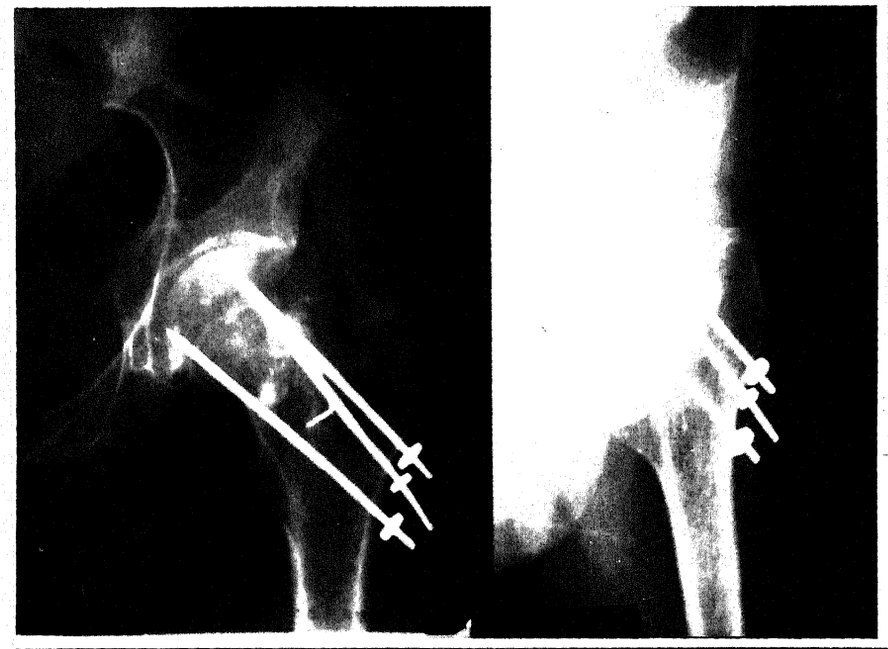


X-ray 8 weeks after operation : showing maintained reduction, fixation, reconstruction of neck with evidence of union.

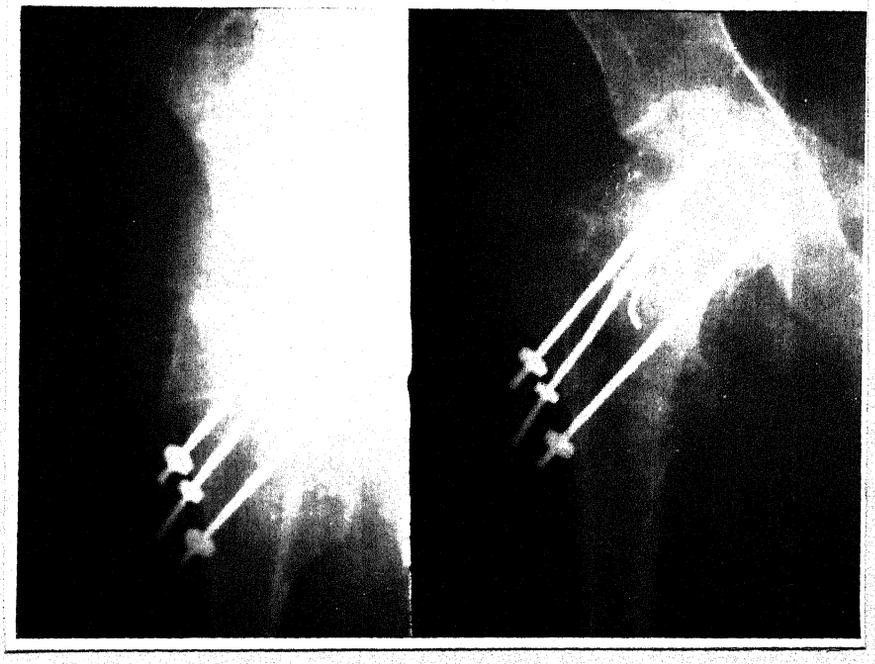


Pre-operative X-ray : showing intracapsular fracture neck femur.

X-ray immediately after operation : showing good reduction and secured internal fixation.

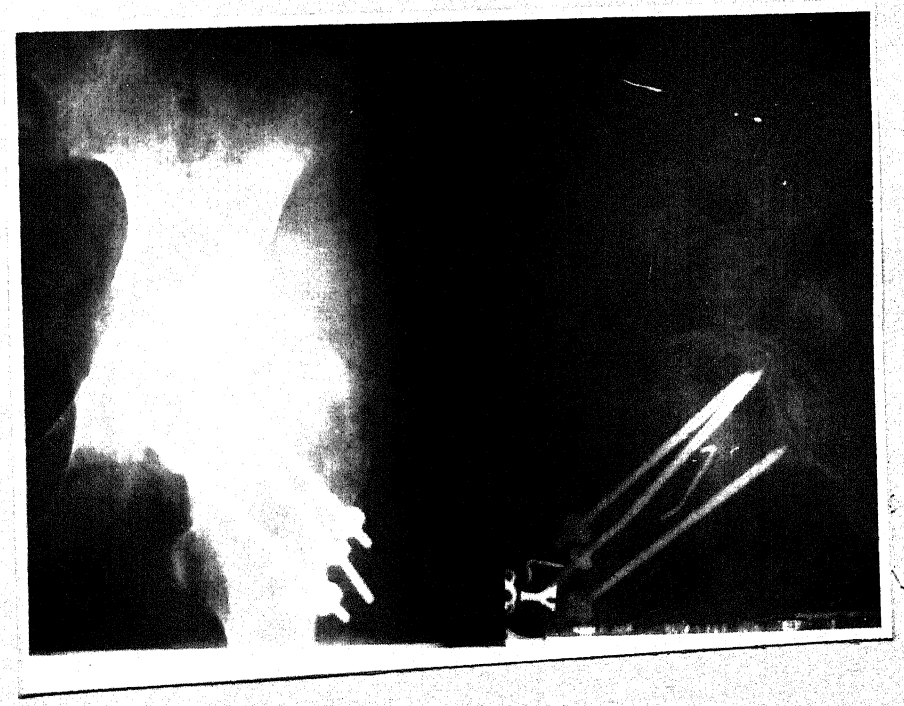


X-ray 8 weeks after operation : showing maintained reduction and fixation.



X-ray 12 weeks after operation : showing evidence of union.

X-ray 16 weeks after operation : showing evidence of union. Callus is seen.



X-ray 20 weeks after operation : showing evidence of union. Callus is seen.

X-ray 26 weeks after operation : showing consolidation of fracture.

DISCUSSION

DISCUSSION

Femoral neck fracture though common in occurence and known since time immemorial, has always been posing challenge to orthopaedic surgeons. Inspite of voluminous work and various modalities of treatment available, significant differences of opinion regarding the best method of treatment persists even today. Anatomical reduction, impaction and rigid internal fixation are considered to be the pre-requisites for union of femoral neck fractures. Non-union and avascular necrosis of femoral head are the frequent complications faced by the orthopaedic surgeons, irrespective of the method of treatment. Most orthopaedic surgeons also agree that viable femoral head has good functional results, as compared to prosthetic head. To overcome these problems, many surgeons (Helstadius, 1942; Stuck and Hinchey, 1944; Baadsgaard and Medgyesi, 1965) came up with the idea of increasing the vascularity of femoral head by viable muscle pedicle bone graft.

Femoral neck fracture, though occurs at all the ages, is common in young and elderly persons. The higher incidence of femoral neck fracture in old age, is well established (Frangakis, 1966; Barnes, 1976; Brown, 1976;

Garden, 1976; Preston and Nicoll, 1976). Our observations showed the higher incidence in young adult males which is in contradiction to the established fact of higher incidence in elderly females (Frangakis, 1966; Barnes, 1976; Brown, 1976; Garden, 1976; Preston and Nicoll, 1976). Both these contradictory findings are because the persons beyond the age of 60 years were not included in our study and majority of the patients of this study sustained injury in roadside accidents, to which the young or adult males are more predisposed.

The comminution of posterior cortex was observed as a frequent finding (70%). The frequency of comminution of posterior cortex has also been observed by Frangakis (1966), Barnes et al (1976), Scheck (1979) and Garden (1974). The posterior comminution posed problem in anatomical reduction as well as in fixation. The comminuted fragments either obstructed, and thus made the reduction difficult or the gap created posteriorly posed a problem in assessing the accuracy of reduction. The difficulty in achieving open reduction in presence of posterior comminution has also been observed by Frangakis (1966), Scheck (1979).

The muscle pedicle bone graft apart from providing a viable pedicle, served as a bone graft to fill up the gap in secured fixation of the fragment and to prevent posterio tilt of the femoral head (Meyer's, 1979; Baksi, 1986).

Baksi (1986) also reported that the viable inlay muscle pedicle bone graft encourages osteosynthesis and revascularization of the femoral head. Fixation of muscle pedicle bone graft to the recipient site has been done by silk (Baksi, 1986), screws (Meyer's, Harvey and Moore, 1973) and pins. We fixed muscle pedicle bone graft with the staple as it provides better fixity of graft to recipient site as well as fixed two fragments of fracture when proximal fragment was big. Baksi (1986) reported that fixation of muscle pedicle bone graft by silk appeared more advantageous than that achieved by screws or pins.

Twenty five percent of cases had interposition of the capsule in between fragments and if not removed, would have caused the problem in union of the fractures by the procedure in which open reduction was not done. The interposition of capsule at fracture site has also been reported by Campbell's Operative Orthopaedics, Volume three, seventh International Student edition, edited by A.H. Crenshaw, page 2084.

Open reduction thus provides an opportunity to inspect the fracture site and removal of the interposed soft tissue if any, which is known to cause nonunion.

Sclerosis at fracture site and absorption of neck were also observed in old neglected cases, which are the established features of nonunion. The open reduction gave

the opportunity of refreshening of fracture surfaces and drilling of sclerosed bone which are again the pre-requisites for osteosynthesis.

Posterior capsulotomy did not hamper the vascularity at fracture site as revealed by the fact that there is no appreciable bleeding on capsulotomy. Similar observations were reported by Baksi (1986). Open reduction also gave an opportunity of drilling the femoral head through fracture surfaces which decompressed any necrotic bone and encouraged the growth of vascular granulation tissue and packing of free cancellous bone grafts between the fracture surfaces helped to restore the femoral neck length. Baksi (1986) also described the above advantages of open reduction.

Inspite of meticulous care, good reduction could be achieved only in 75% of cases. Posterior comminution, absorption of neck, small proximal fragment (only head) and anatomical architecture of the area are the main obstacles. Difficulty in achieving anatomical reduction has also been observed by Frangakis (1966), Barnes (1976) and Scheck (1979).

Good reduction and rigid internal fixation were the pre-requisites for union, as one case where the fixation was not secured and in another case in which reduction could not be achieved landed up in nonunion, as also reported by

Frangakis (1966), Barnes (1976), Brown (1976), Garden and Nicoll (1976).

Upto 20° of coxa valga was considered to be acceptable position and satisfactory reduction. Extreme valgus reduction was avoided and varus reduction was not accepted as also suggested by Bunata et al (1959). Garden (1966) also warned against severe valgus reduction which increases the risk of avascular necrosis and nonunion. Angle smaller than 160° denotes unacceptable varus reduction and angle more than 180° denote severe valgus reduction.

Frangakis (1966) also stressed upon accuracy of reduction and considered an angle of 165° as normal relation between head and neck in this plane. Any reduction above this angle was considered as imperfect reduction. He also observed that fixation in more than 20° valgus malposition has catastrophic effect on the viability of head.

Similar findings were observed in the present study as two cases in whom the reduction could not be achieved or lost in post-operative period ultimately landed in nonunion and had poor results (It is not possible to comment on viability of femoral head, as follow-up period was short).

Deyerle (1965), on the contrary, recommended valgus reduction because it shortens the neck and decreases the lever arm of proximal fragment which decreases the

amount of motion at fracture site. Barnes et al (1976) reported the higher incidence of late segmental collapse when the fracture was fixed with Garden angle more than 180°.

Frangakis (1966) on the other hand, said that rotation in horizontal plane has no significant effect on avascular necrosis of the femoral head.

Retention of reduction obtained by internal fixation though was not difficult but rotation of femoral head with striking of first pin and occasionally of second pin posed some problem especially when the proximal fragment was short. Introduction of subsequent pin did not cause any rotation of the femoral head, thus the fixation by multiple pins provides rigid internal fixation, a pre-requisite for union of fracture. Multiple pin fixation has also been recommended by Deyerle (1965), Neufield (1973), Arnold (1984) and many others.

Deyerle (1986) mentioned the principle of multiple peripheral pin fixation in relation to the distribution of stress in femoral head. With a triflanged nail, it is comparable to breaks applied on the axle. With multiple peripheral pins, it can be likened to breaks applied to the peripheral drum.

The pins take up a smaller area of the neck and cause negligible damage to blood supply of the femoral head as compared to triflanged nail as was also reported

Enough cancellous bone grafts could be taken from greater trochanter except when there was marked absorption of neck and amount of bone grafts needed was more. With the use of greater trochanter as a donor site, advantages were - the grafts could be removed by same incision, from same operative field, did not cause much bleeding, did not add to the operative time, did not cause any harm and at the same time provided good quality of cancellous bone. Baksi (1986) has also used the cancellous bone grafts from greater trochanter and reported good results.

Good reduction and rigid fixation permitted early physiotherapy and majority (except those with marked absorption of neck) of patients could be out of the bed within 6 - 12 weeks with crutches. Full unsupported weight bearing, however, was not permitted before the consolidation at the fracture site (4 - 6 months). Early weight bearing was not possible where there was marked absorption of neck or reduction and fixation was not accurate. These cases had to be immobilized with plaster spica for 2 - 4 months till the fragments became sticky. Immobilization by hip spica in cases of absorption of neck and unsecured fixation was recommended by Baksi (1986). Plaster boot and de-rotation bar as a method of immobilization was not used as there was risk of mechanical disadvantage in the form of rotation.

at the fracture site. However, Baksi (1986) used plaster boot and de-rotation bar and reported good results.

Few complications were encountered in this procedure in the form of superficial infection (15%), loss of fixation (5%), avascular necrosis (5%) and extrusion of pins (5%).

Bending and breaking of pins did not occur in any case of our study. However, Baksi (1986) reported bending and breaking or extrusion of the pins in 16% of cases and attributed them to premature weight bearing.

Collapse of femoral head occurred only in one case where Mc Murray's osteotomy had already been done earlier but the femoral neck fracture did not unite and this procedure was done 2 years after the fracture. Baksi (1986) also reported segmental collapse in 2 out of 56 cases, treated by this procedure, which was detected 18 - 22 months after the operation. In our study, the collapse occurred only in one case, though the follow-up is short. Scheck (1967) believes that open reduction is usually associated with higher incidence of nonunion, possibly because of interference with remaining retinacular blood supply. However, the present study and that of Baksi (1986) shows lower rate of nonunion and avascular necrosis of femoral head. Probably due to the viable muscle pedicle bone grafting.

Results were evaluated on the basis of union, functions, residual disability, pain, movements, shortening and gait.

Union occurred in 85% of cases. All except one (5%) were able to walk unsupported, had good painless range of movements of hip, could squat and sit cross-legged and hence were graded as good results. One case (5%) who had union but restriction of adduction, internal rotation with pain at extremes of movements, had difficulty in squating and was unable to sit cross-legged, could walk unsupported, was graded as satisfactory result. The restriction of movement was probably because of lack of co-operation of patient and physiotherapy. Baksi (1986) also reported union in 87.5% of cases (satisfactory union in 75% and delayed union in 12.5% of cases). Meyer et al (1974) reported rate of union as 90%.

In 3 (15%) cases, fracture failed to unite, but one of them who had undergone Mc Murray's osteotomy earlier could walk unsupported but had painful range of movements was happy as stability of hip improved and pain was relieved (probably by fixation of fragments by pins) was also graded as satisfactory result. Two (10%) cases had nonunion, one due to technical failure and other due to faulty fixation. Both these patients had shortening, were unable to walk unsupported, with restriction of movements at hip, were graded as poor results. Baksi (1986) also reported nonunion in 12.5% of cases and technical failure in two (2) cases.

A published study at the Los Angeles County University of Southern California Medical Centre, reports 35% incidence of nonunion in a study of 250 cases before introduction of muscle pedicle bone graft technique. Significant improvement in these results was noted following introduction of muscle pedicle bone graft technique and reported rate of union as 95% and late segmental collapse in 5% of cases that united.

This technique thus provides higher rate of union, reduces the risk of avascular necrosis and segmental collapse, retains the natural head and provides better quality of life.

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CONCLUSIONS

CONCLUSIONS

Twenty cases of femoral neck fractures both fresh as well as neglected or ununited, were treated by open reduction, internal fixation with multiple Austin Moore's pins with muscle pedicle bone grafting. Following conclusions were drawn :

1. Open reduction provides an opportunity of direct visualization of the fracture site.

2. Soft tissue interposition in the form of capsule can be removed which is otherwise not possible by closed reduction.

3. Open reduction also provides an opportunity to freshen the fracture surfaces and decompression of necrotic bone which encourages the growth of vascular granulation tissue, so useful for union.

4. Posterior capsulotomy does not hamper the blood supply of femoral head.

5. Accuracy of reduction of fracture can be viewed directly.

6. Multiple pins provide secured fixation and cause minimum damage to cancellous bone.

7. Inlay muscle pedicle bone graft increases the vascularity, acts as strut across the posterior cortical defect, prevents posterior tilt of femoral head, thus encourages osteosynthesis and revascularization of femoral head.

8. The rate of union is higher, in the cases treated by open reduction, internal fixation with muscle pedicle bone grafting as compared with other methods of treatment.

9. The rate of avascular necrosis and segmental collapse is reduced.

10. The natural femoral head is retained, which provides better quality of life.

11. The complications are few and insignificant.

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S U M M A R Y

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Femoral neck fractures, though known from time immemorial, and still continuing as a common orthopaedic problem, especially regarding nonunion and avascular necrosis. Non-union and avascular necrosis after femoral neck fracture is a challenging problem even today. It poses great challenge to orthopaedic surgeons regarding its management. Significant differences of opinion persist regarding the modalities of treatment that are used.

The key to get success in management of these fractures is anatomical reduction, impaction and rigid fixation.

Development of late segmental collapse due to avascular necrosis inspite of anatomical reduction and secured fixation led the surgeons to think upon the third essential factor of improving the vascularity of femoral head.

Meyer et al in 1974 reported in his series of 144 cases that in femoral neck fractures treated by muscle pedicle bone grafting alongwith internal fixation; the rate of union was 95% and late segmental collapse occurred in only 5% of the cases which had united.

Baksi in 1986 treated 56 patients of ununited femoral neck fractures by internal fixation with Moore's pins alongwith muscle pedicle bone grafting and achieved union in 87.5% of cases and avascular necrosis in 3% of cases.

The aim of our present study is to establish the role of open reduction, internal fixation with muscle pedicle bone grafting for the management of fresh, neglected as well as ununited femoral neck fractures.

The variety of factors contributing to the problems of non-union and late segmental collapse have been reviewed by many authors. Barnes and associates in 1976 divided the source of trouble into two groups :

1. Those over which surgeon has no influence. This includes - old age, female sex, high level of fracture, Garden type III or IV fractures and osteoporosis.

2. Those over which surgeon has great deal of influence - the acceptance of extreme valgus or varus reduction, high and anterior placement of fixation device, comminution and premature ambulation.

A study of 20 cases of fresh as well as neglected or ununited femoral neck fractures treated by multiple Moore's pins fixation with muscle pedicle bone grafting was conducted at Orthopaedics Out Patient Department and Emergency Department of M.L.B. Medical College Hospital, Jhansi.

Quadratus femoris muscle alongwith bone graft of size of length of entire width of quadratus femoris muscle x 1.5 to 2 cm. broad x 1 to 1.5 cm. thick from inter-trochantric crest was lifted and fixed, in the gutter made on posterior surface of neck and head, with staple after fixation of fracture by Moore's pins. The age of patients varied from 14 to 60 years with the average age of 37 years. The majority of cases were transcervical and Garden type III fractures. 50% of cases were fresh as they could be operated within 3 weeks of injury and rest of them were either neglected or ununited fractures. Per-operative, 70% of cases showed marked posterior comminution and in 25% of cases inter-position of capsule or periosteum layer was found. Posterior comminution posed difficulty in reduction. Pins provided secured fixation, union occurred in 85% of cases.

The muscle pedicle bone graft spanning the fracture united to the head and neck of the femur when fragments were in either a satisfactory or in slight valgus position. The grafts remained viable throughout. There was no instance in which the bone of the muscle pedicle graft appeared to be absorbed or decreased in size. An increase in the size of bone graft was frequently noted on roentgenograms.

The cases having good to satisfactory reduction were united except 2 cases. One out of these two cases

had earlier undergone for Mc Murray's osteotomy and he went for muscle pedicle bone grafting after 2 years, developed avascular necrosis and his fracture remained ununited. In other case, fixation was insecure and reduction lost in second follow-up radiograph. Two out of 19 cases of secured fixation went under non-union. In one out of these two cases, reduction could not be achieved and the other case had earlier undergone Mc Murray's osteotomy as described above.

Out of 20 cases, 3 (15%) developed superficial infection which was controlled by systemic antibiotics and with sterile dressings. One case (5%) developed avascular necrosis but this case had undergone Mc Murray's osteotomy earlier. One case (5%) showed extrusion of pins.

Union occurred in 85% of cases. All of whom except one were able to walk unsupported, had good range of movements at hip joint, could squat and sit cross legged and hence were graded as good result (80%). One case who had union but had restriction of adduction and internal rotation with pain at extremes of movements, was graded as satisfactory result.

In three cases fracture failed to unite but one of them, who had undergone earlier Mc Murray's osteotomy could walk unsupported and had painless range of movements, was also graded as satisfactory result. This patient was very happy as the stability of hip improved and pain was

relieved. Two cases had non-union and could not walk unsupported were graded as poor results (10%).

Following conclusions were drawn from the present study -

1. Open reduction provides an opportunity of direct visualization of the fracture site.

2. Soft tissue interposition in the form of capsule can be removed which is otherwise not possible by closed reduction.

3. Open reduction also provides an opportunity to freshen the fracture surfaces and decompression of necrotic bone which encourages the growth of vascular granulation tissue, so useful for union.

4. Posterior capsulotomy does not hamper the blood supply of femoral head.

5. Accuracy of reduction of fracture can be viewed directly.

6. Multiple pins provide secured fixation and cause minimum damage to cancellous bone.

7. Inlay muscle pedicle bone graft increases the vascularity, acts as strut across the posterior cortical defect, prevents posterior tilt of femoral head, thus encourages osteosynthesis and revascularization of femoral head.

8. The rate of union is higher, in the cases treated by open reduction, internal fixation with muscle pedicle bone grafting as compared with other methods of treatment.

9. The rate of avascular necrosis and segmental collapse is reduced.

10. The natural femoral head is retained, which provides better quality of life.

11. The complications are few and insignificant.

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